C1 BSAI CRAB STOCKS

KATIE PALOF & MIKE LITZOW

CPT MEETING MINUTES – SEPT 12-15TH, 2022

BSAI CRAB STOCKS MANAGEMENT TIMING

Aleutian Islands golden king crab
Pribilof Islands blue king crab *
Pribilof Islands golden king crab *
Western Aleutian Islands(Adak) red king crab *

Biennial cycle, next assessment in 2023

Assessed in May/June

Triennial cycle, next assessment in 2023

EBS snow crab
Bristol Bay red king crab
EBS Tanner crab
Pribilof Islands red king crab *
St. Matthew blue king crab *

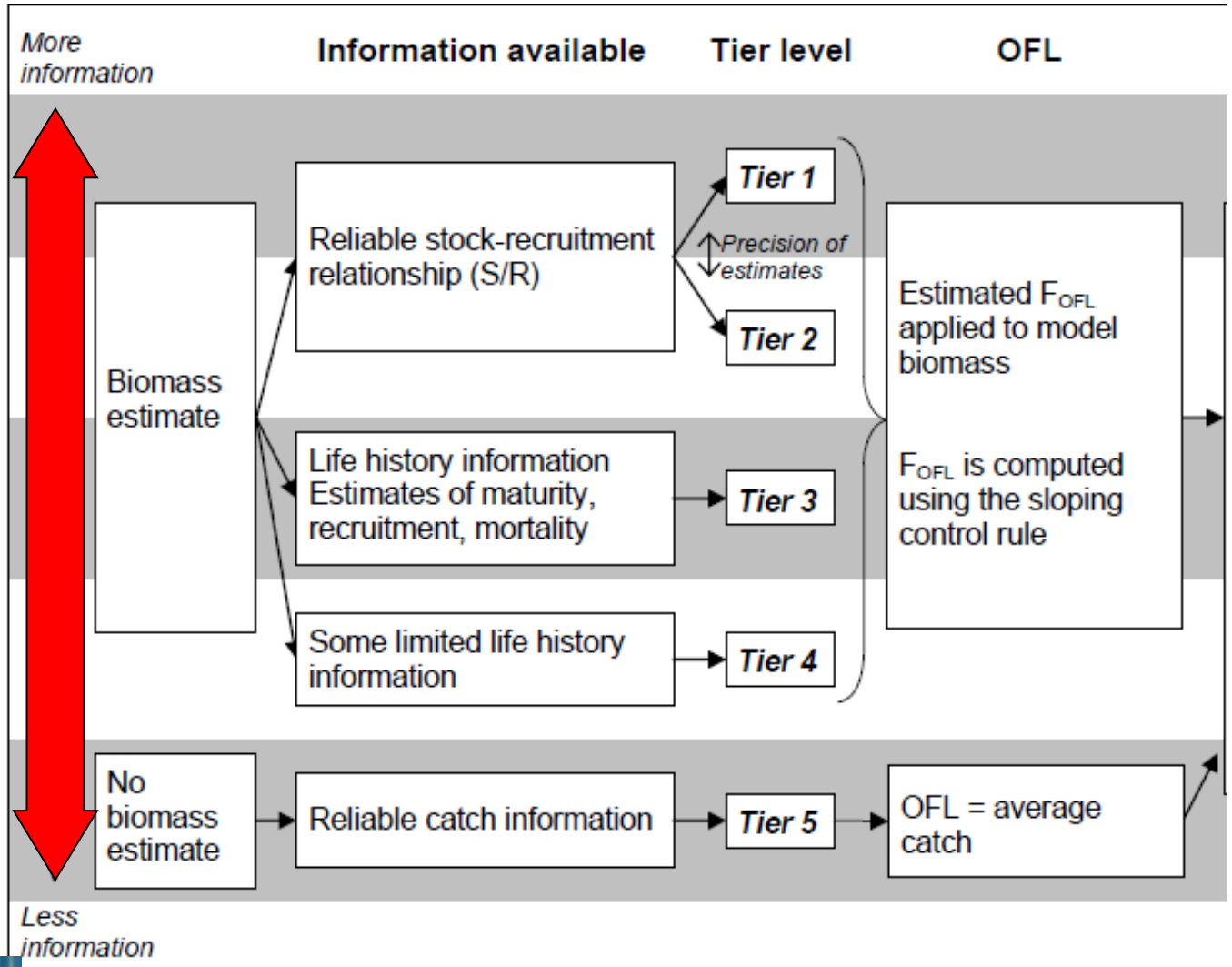
Assessed in September/ October

Triennial cycle, next assessment in 2022

Biennial cycle, next assessment in 2022

Norton Sound red king crab

Assessed in January/ February



ABC buffer

10-20%

10-25%

25-40%

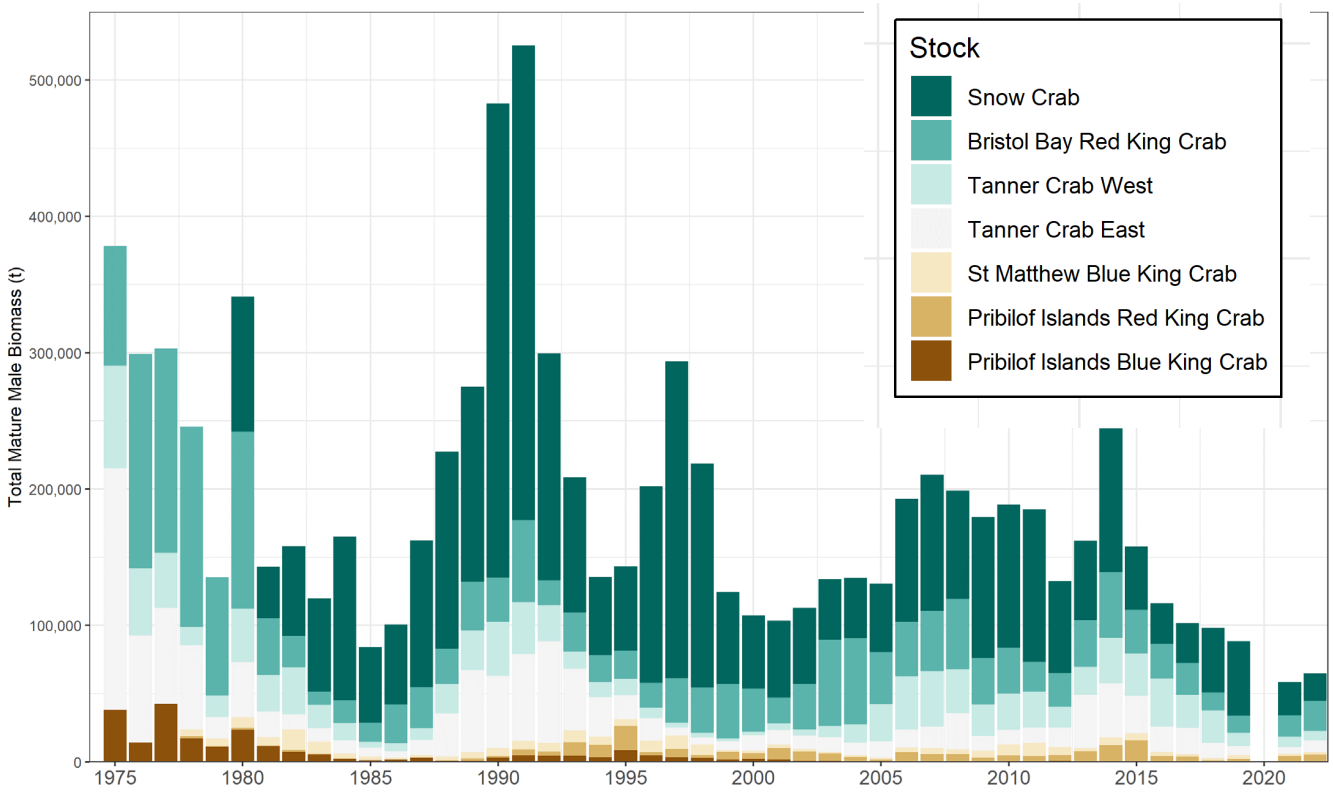
SEPT 2022 AGENDA

- **BBRKC final assessment, OFL and ABC, ESP report card update**
- **Tanner crab final assessment, OFL and ABC**
- **SMBKC final assessment, OFL and ABC, ESP report card update**
- **PIRKC final assessment, OFL and ABC**
- **Snow crab final assessment, OFL and ABC, ESP**
- Snow crab rebuilding projections (decisions for initial review in Dec.)
- NSRKC, proposed model runs
- 2022 bottom trawl survey results
- Fishery summary 2021/22
- Overfishing updates: WAIRKC, PIGKC, PIBKC, AIGKC
- EFH fishing effects model – comments/recommendations from CPT
- Ecosystem status report
- Climate model updates
- BSFRF research updates
- GMACS updates

BERING SEA BOTTOM TRAWL SURVEY

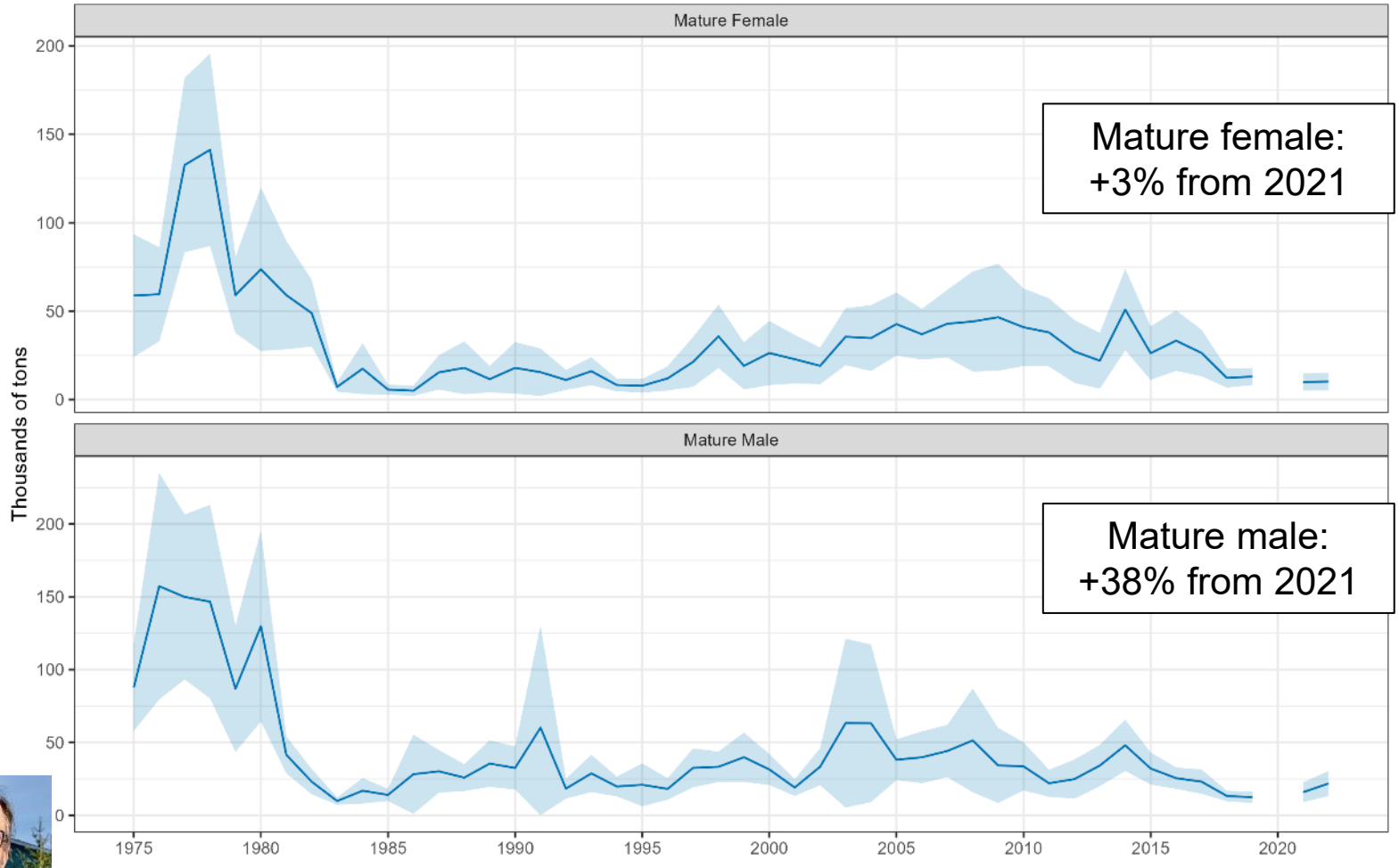
2022 RESULTS OVERVIEW

MATURE MALE BIOMASS

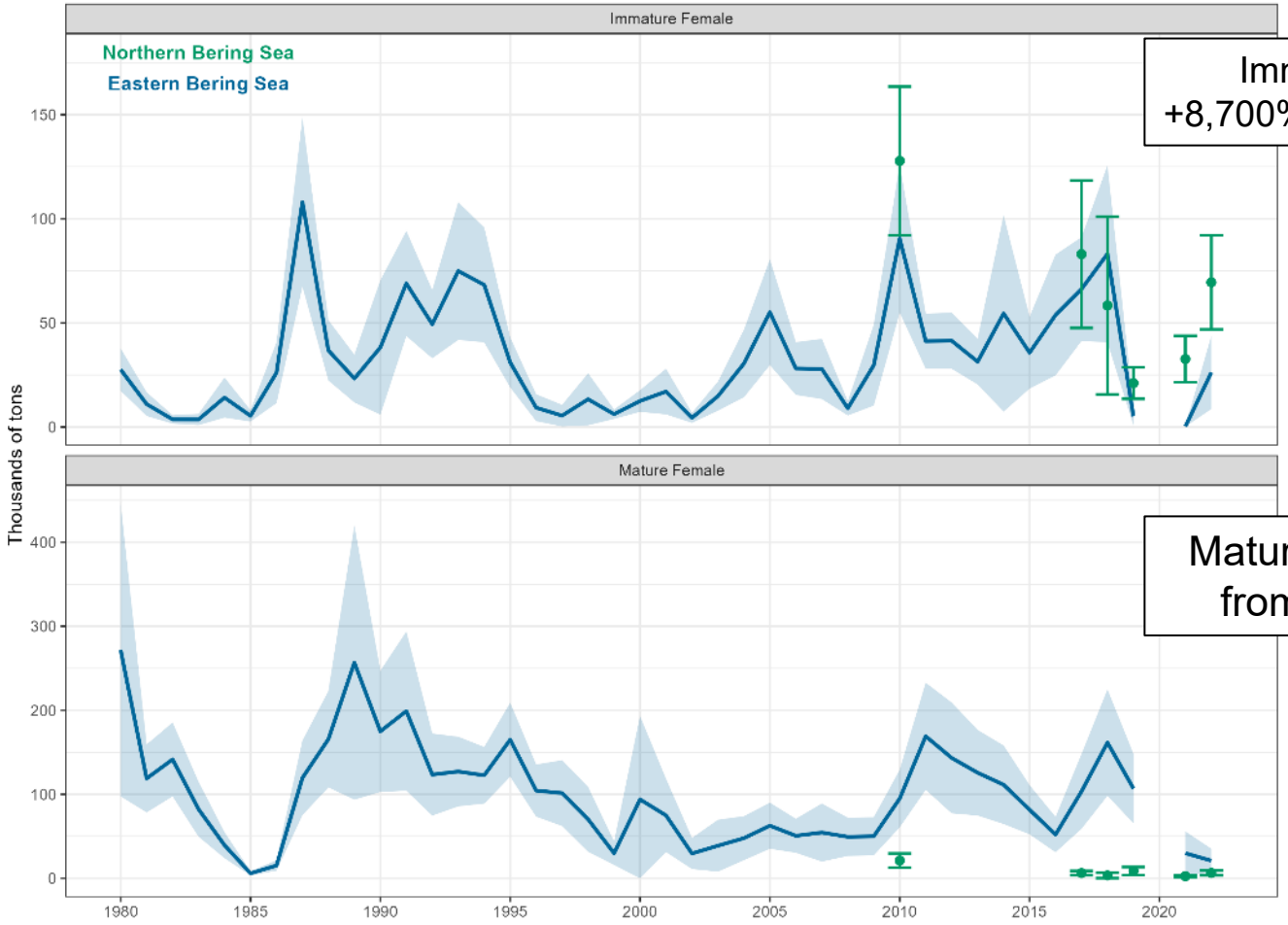


- Total mature male biomass 11% higher than 2021
- Second-lowest value in time series

BRISTOL BAY RKC BIOMASS



FEMALE SNOW CRAB BIOMASS



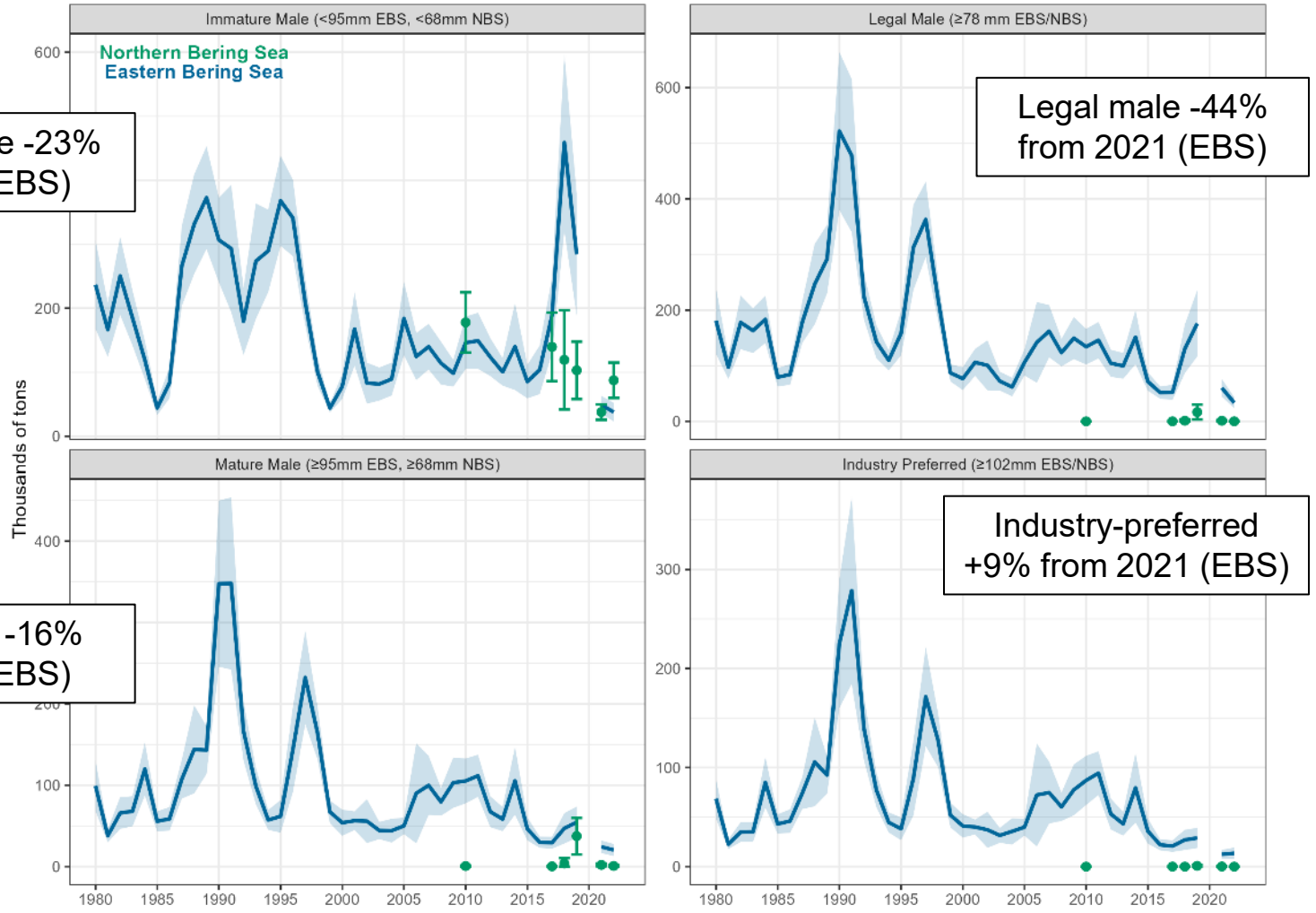
Immature female
+8,700% from 2021 (EBS)

Mature female -16%
from 2021 (EBS)

MALE SNOW CRAB BIOMASS

Immature male -23% from 2021 (EBS)

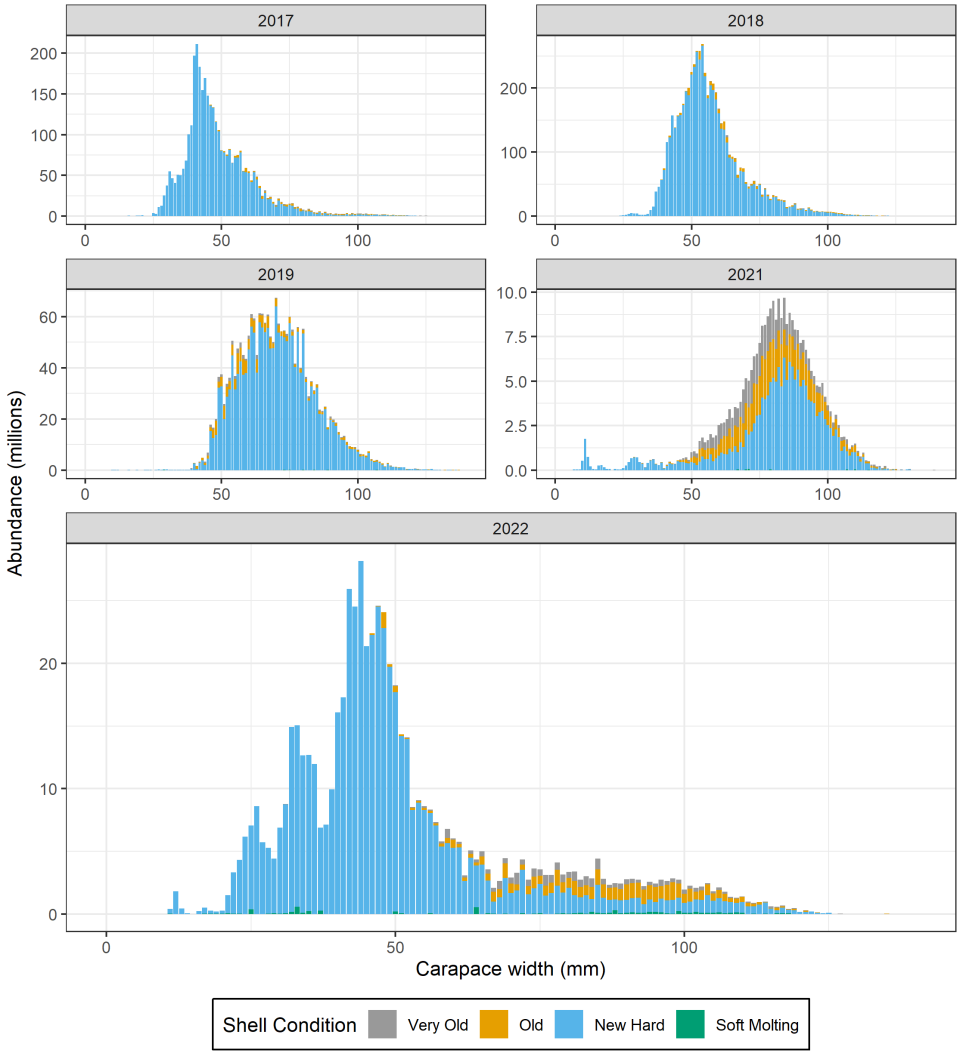
Mature male -16% from 2021 (EBS)



Legal male -44% from 2021 (EBS)

Industry-preferred +9% from 2021 (EBS)

MALE SNOW CRAB SIZE COMPOSITION AND SHELL CONDITION



- Increase in the smallest size classes
- Immature *abundance* +138% from 2021 (immature *biomass* -23%)

TANNER CRAB

- Biomass for all size-sex categories down west of 166° W
- Mixed results east of 166° W
  - Mature female biomass down 36% from 2021
  - Mature male biomass up 74% from 2021, remains at low level
- High abundance of small crab failing to appear as larger sizes in subsequent years

BBRKC

FINAL ASSESSMENT 2022

ESP SUMMARY CONSIDERATIONS

Ecosystem:

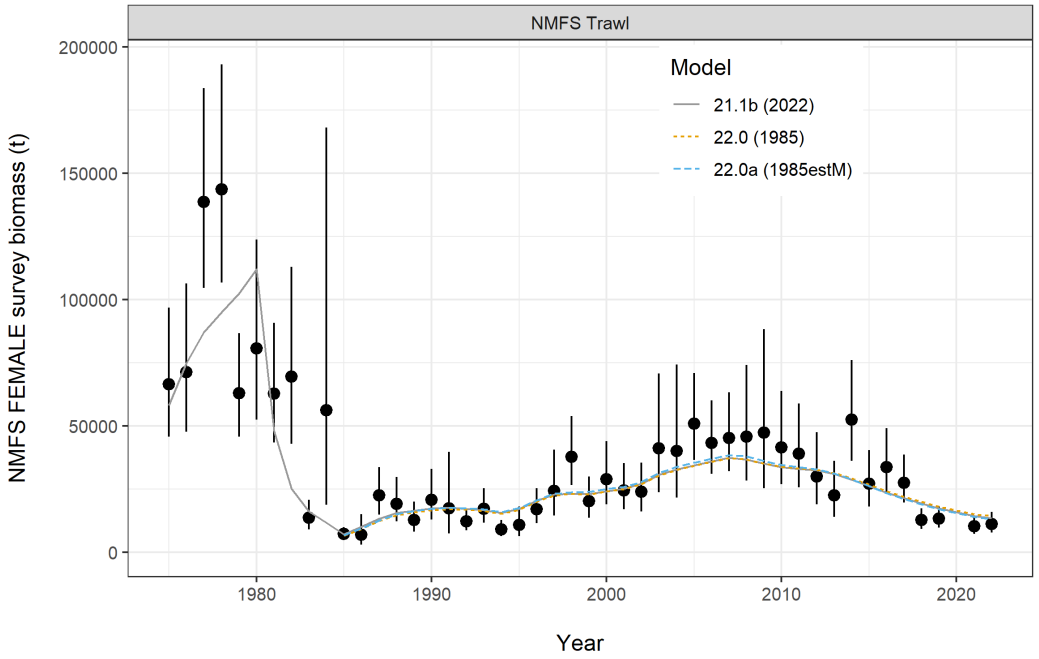
- In 2022, **bottom temperatures returned to near-average** and the cold pool extended into the Bristol Bay management area.
- Red king crab have experienced a **steady decline in bottom water pH** in the past two decades, reaching 7.89 in 2022. Continued declines to threshold pH levels of 7.8 could negatively affect juvenile red king crab growth, shell hardening and survival.
- BBRKC **recruitment remains well below the long-term average**. Concurrent declines in Pacific cod and benthic invertebrate densities in the past 7 years may suggest shared processes that drive productivity of Bristol Bay benthic communities.
- **Spatial extent** of mature male red king crab in Bristol Bay was **above average** in 2022, coinciding with increases in abundance.

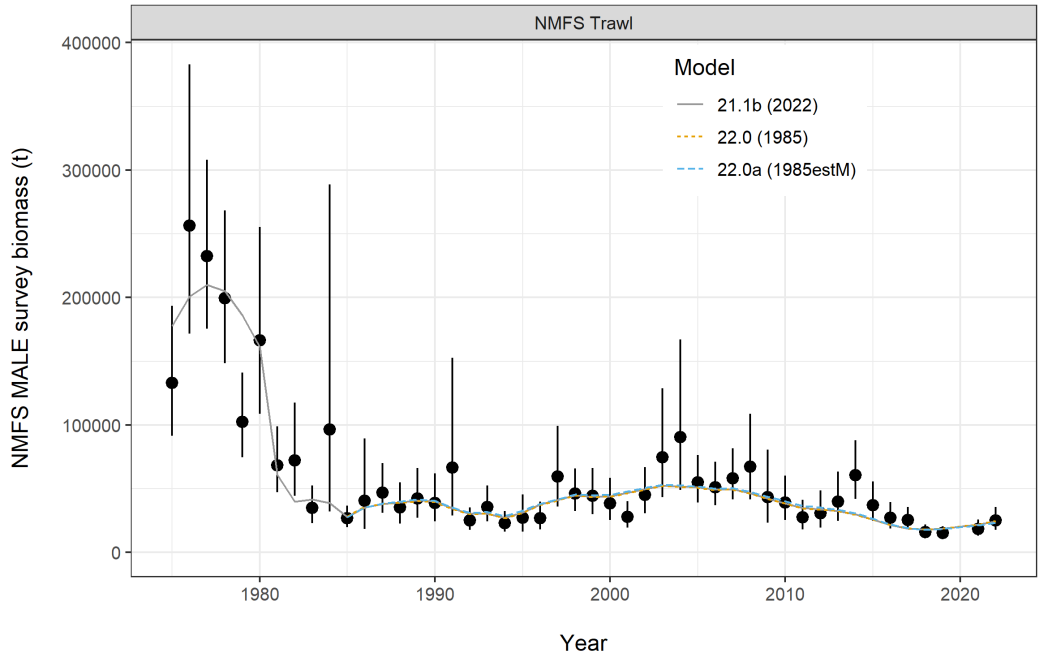
Socioeconomic:

- The BBRKC fishery was closed to targeted fishing for the 2021/2022 season.
- Incidental catch of BBRKC biomass in EBS groundfish fisheries during 2021 increased moderately from the previous year to slightly above average for the 2010-current period.

BBRKC FINAL ASSESSMENT 2022 - SUMMARY

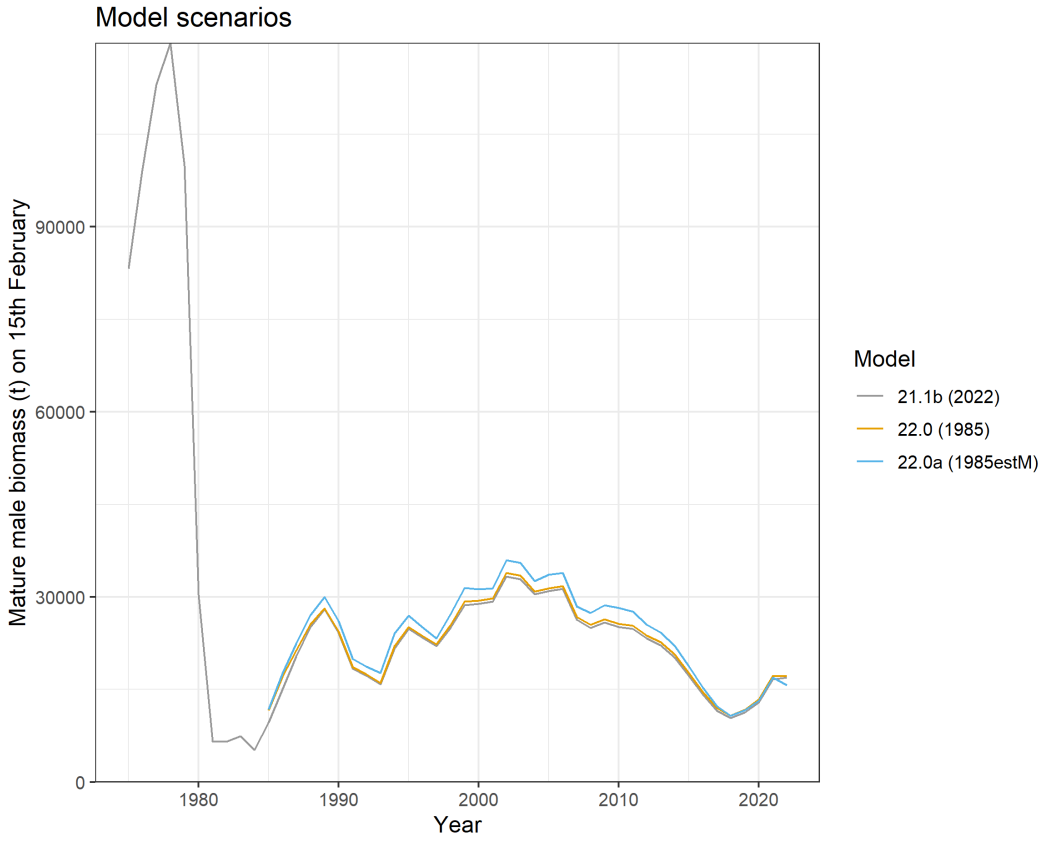
- Survey estimated mature male biomass increase from 2021 (+30%), still low compared to long term average
- Estimated mature female biomass is higher than 2021 but still lower than it's been since the mid-90s
- Directed fishery was closed in 2021/22 season due to low mature female abundance.
- 2022 mature female abundance estimate does NOT meet the minimum threshold of mature female abundance (8.4 million) in the State Harvest Strategy
  - 2022 area-swept = 8.004
  - 2022 model estimate = 7.840
- Low recruitment in recent years (last 8-12 years); biomass is projected to decline without a large recruitment event (with fishing mortality >0)
- Model scenarios include base/reference model and models that change the start date of data into the model from 1975 to 1985



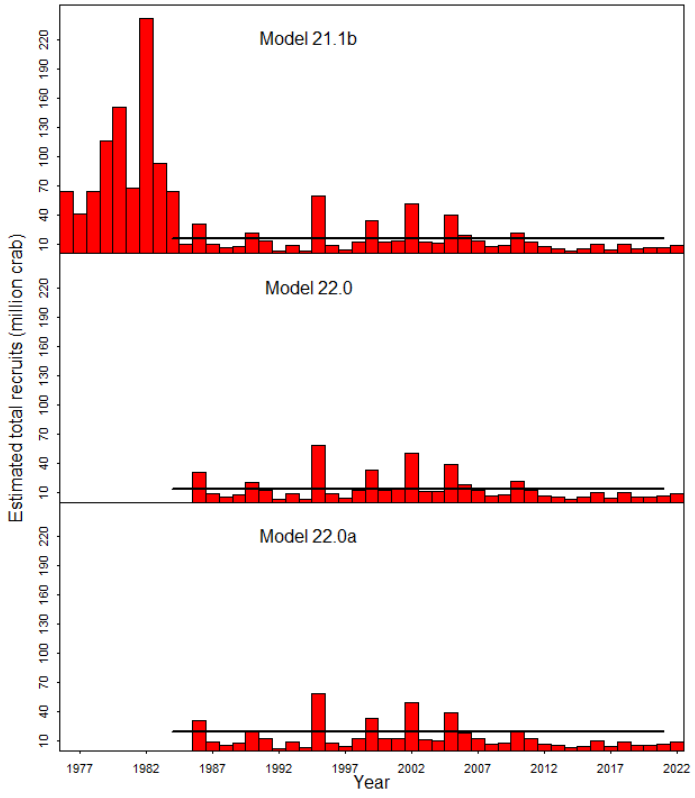


- ✓ Model fits to survey data are similar in all 3 models.
- ✓ Mature females still declining in modeled survey estimate (top)
- ✓ Mature males small increase in modeled survey (bottom)

MATURE MALE BIOMASS



RECRUITMENT



Status and catch specifications (1,000 t) (model 21.1b):

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2018/19	10.62[B]	16.92[B]	1.95	2.03	2.65	5.34	4.27
2019/20	12.72[C]	14.24[C]	1.72	1.78	2.22	3.40	2.72
2020/21	12.12[D]	13.96[D]	1.20	1.26	1.57	2.14	1.61
2021/22	12.01	16.64	0	0.02	0.10	2.23	1.78
2022/23		16.95				3.04	2.43

Basis for the OFL: Values are in 1,000 t (model 21.1b):

Year	Tier	B_{MSY}	Current MMB	B/B_{MSY} (MMB)	F_{OFL}	Years to define B_{MSY}	Natural Mortality
2018/19	3b	25.5	20.8	0.82	0.25	1984-2017	0.18
2019/20	3b	21.2	16.0	0.75	0.22	1984-2018	0.18
2020/21	3b	25.4	14.9	0.59	0.16	1984-2019	0.18
2021/22	3b	24.2	14.9	0.62	0.17	1984-2020	0.18
2022/23	3b	24.03	17.0	0.71	0.20	1984-2021	0.18

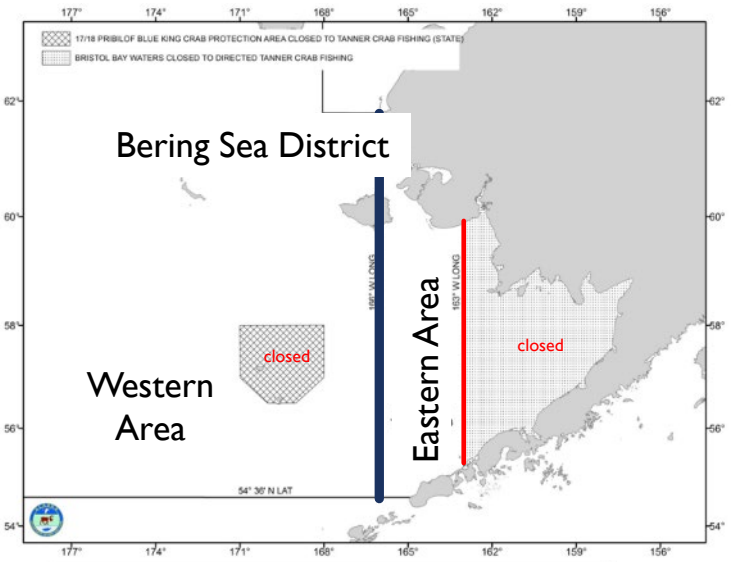
Model 21.1b, base ABC buffer 20%
Total catch << OFL – overfishing not occurring
Stock status > 0.50 and increasing

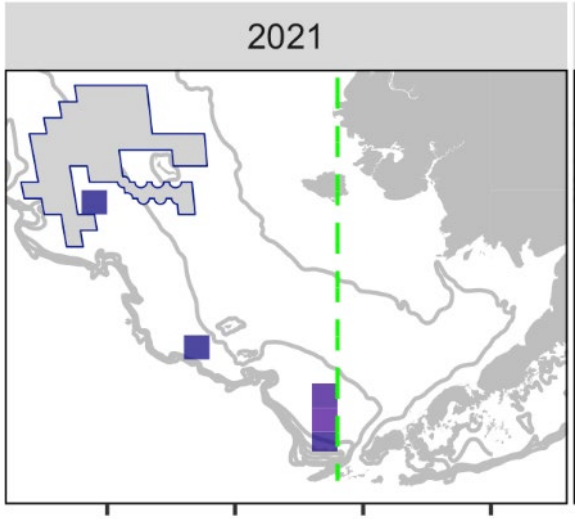
TANNER CRAB

FINAL ASSESSMENT, OFL/ABC SPECS

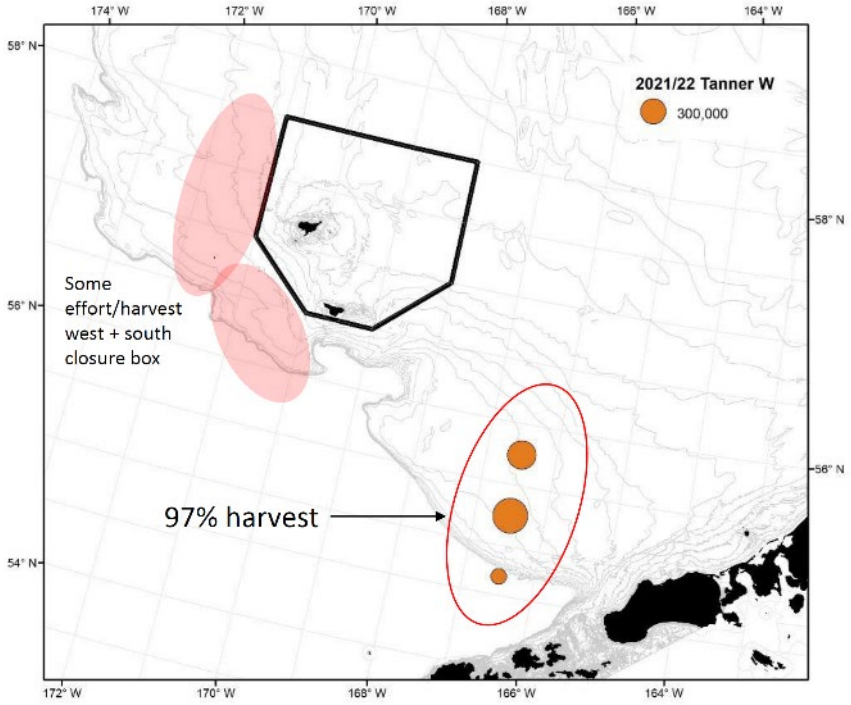
OVERVIEW

- 2021/22 Federal management
  - OFL: 27,170 t
  - ABC: 21,740 t
  - Total catch mortality: 780 t (< OFL)
    - **overfishing did not occur**
    - mostly taken in directed fishery
  - 2021/22 MMB: 62,050 t (> MSST = 17,370 t)
    - **stock is not overfished**
- ADFG management
  - Eastern Area closed
    - MMB failed to meet threshold
  - Western Area
    - TAC: 499 t
    - Retained catch: 494 t
    - 19,252 potlifts
    - CPUE: 26 kg/pot (+25%)





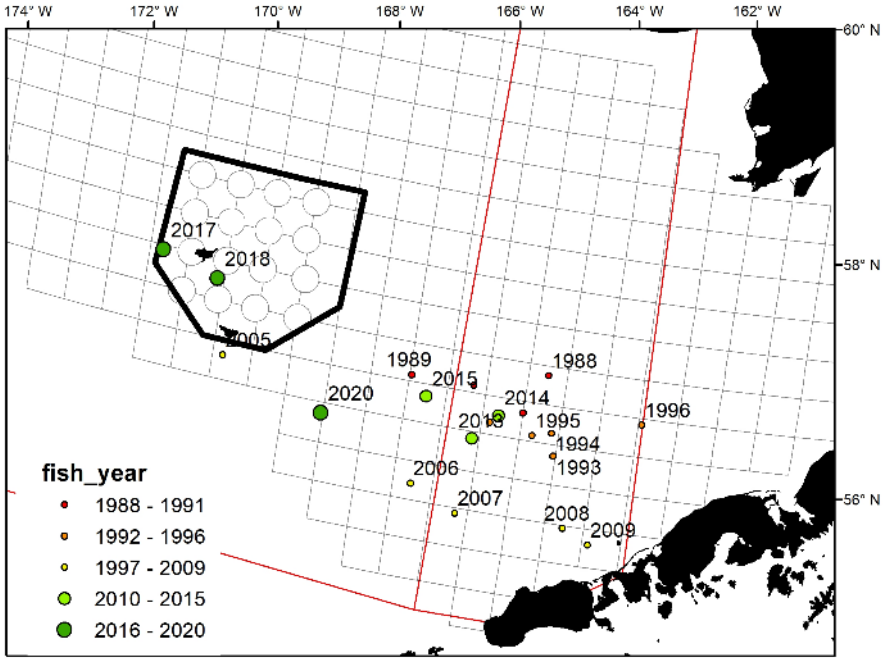
2021/22 TANNER CRAB RETAINED CATCH



*Excludes stat areas with <3 vessels

Fleet observations:

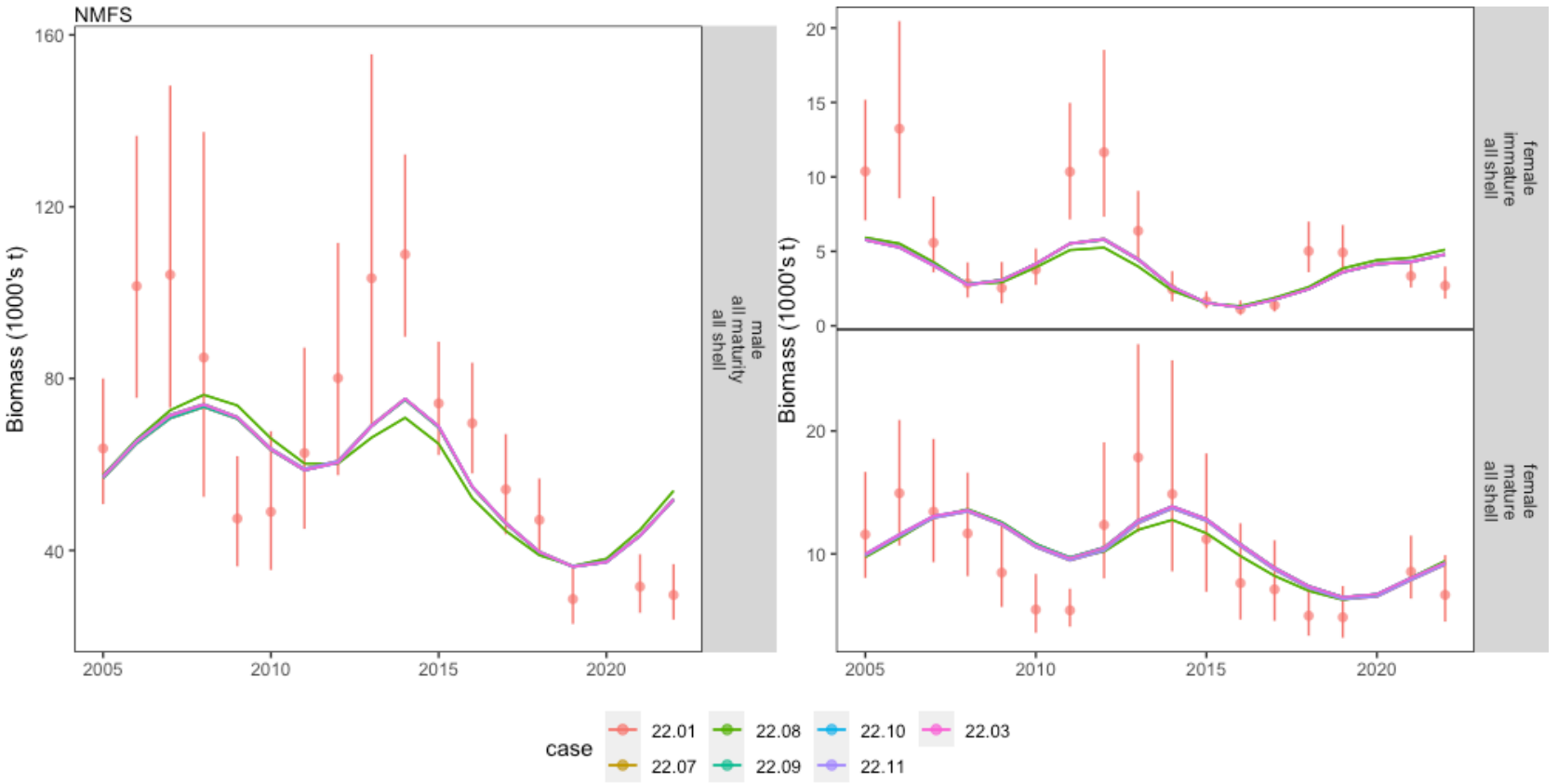
- CPUE approximately at rationalized time series average
- Good fishing at the 166 W long boundary
- Retention of more (~35%) sub industry preferred size crab (5 inches, legal is 4.4 inches)



TANNER CRAB OVERVIEW

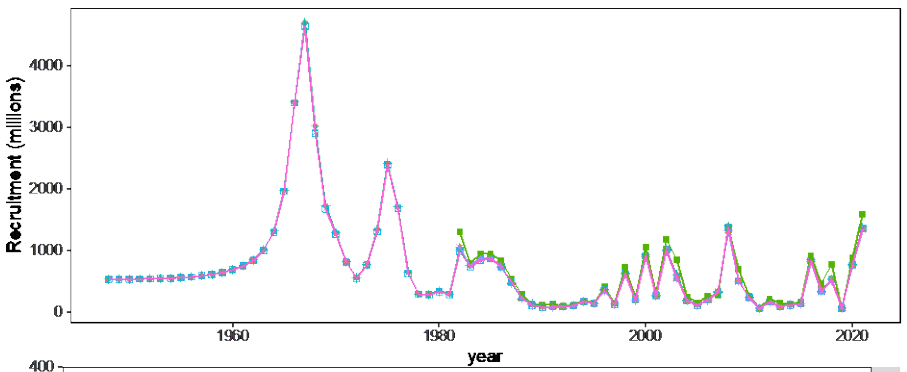
- Models addressed CPT/SSC comments and concerns
- Many were explorations that are not ready for consideration for specification.
- Model 22.03 is a small improvement from last year's accepted model, similar results
- Model fits and estimation was similar among most models
- All models struggle with recruitment (observed in size compositions) that is not matriculating into the population

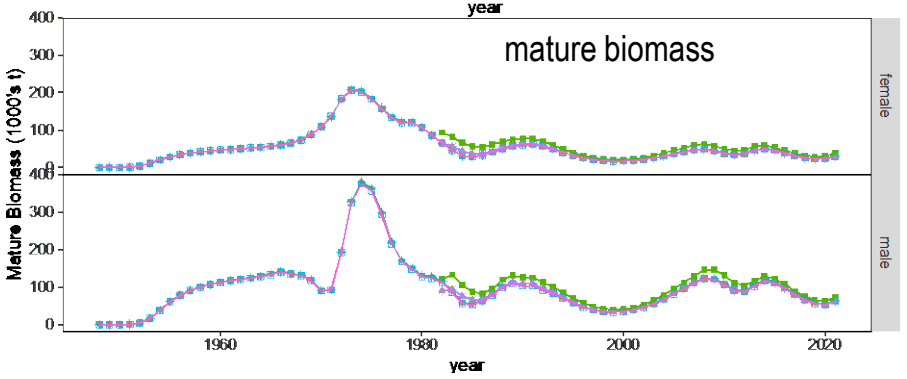
FITS TO NMFS SURVEY BIOMASS



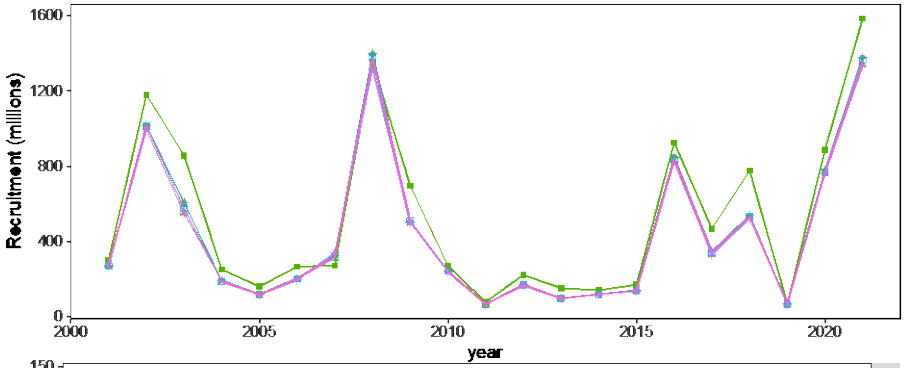
Population Results: recruitment and MMB

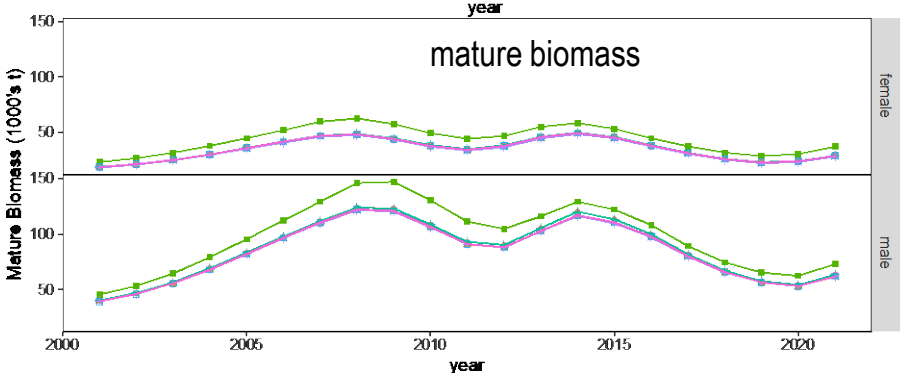
recruitment





recruitment





STOCK STATUS (22.03)

- Tier 3a
- Not overfished
- No overfishing
- 20% ABC buffer

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2017/18	15.15	64.09	1.13	1.13	2.37	25.42	20.33
2018/19	20.54	82.61	1.11	1.11	1.90	20.87	16.70
2019/20	18.31	56.15	0.00	0.00	0.54	28.86	23.09
2020/21	17.97	56.34	1.07	0.66	0.96	21.13	16.90
2021/22	17.37	62.05	0.50	0.49	0.78	27.17	21.74
2022/23	NA	47.58	NA	NA	NA	32.81	26.25

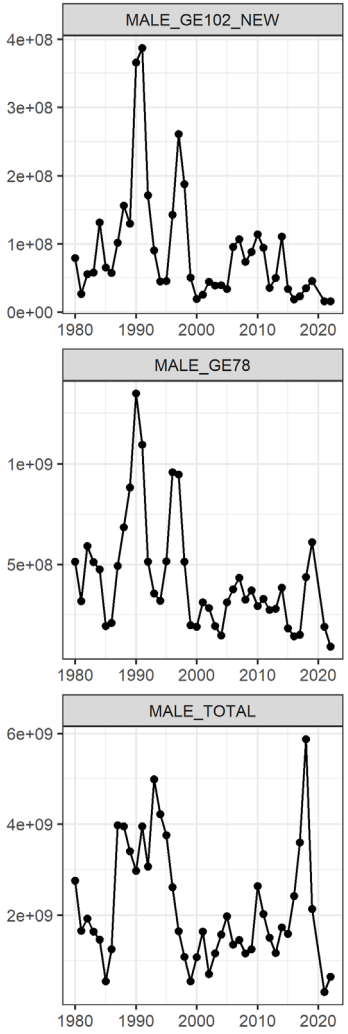
Year	Tier	Bmsy	Projected MMB	B/Bmsy	Fofl	Years to Define Bmsy
2017/18	3a	29.17	47.04	1.49	0.75	1982-2017
2018/19	3a	21.87	23.53	1.08	0.93	1982-2018
2019/20	3b	41.07	39.55	0.96	1.08	1982-2019
2020/21	3b	36.62	35.31	0.96	0.93	1982-2019
2021/22	3a	35.94	42.57	1.18	1.17	1982-2020
2022/23	3a	34.73	47.58	1.37	1.17	1982-2021 *

M: immature: 0.24, females: 0.31, males: 0.31 (Table 52, p. 132)

SNOW CRAB

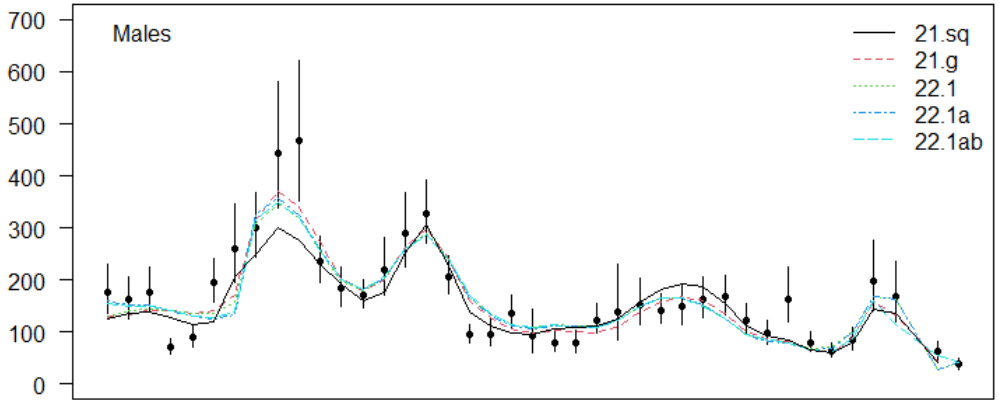
FINAL ASSESSMENT, OFL/ABC SPECS, REBUILDING

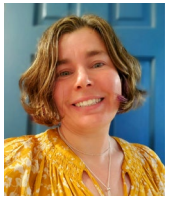
STOCK STATUS



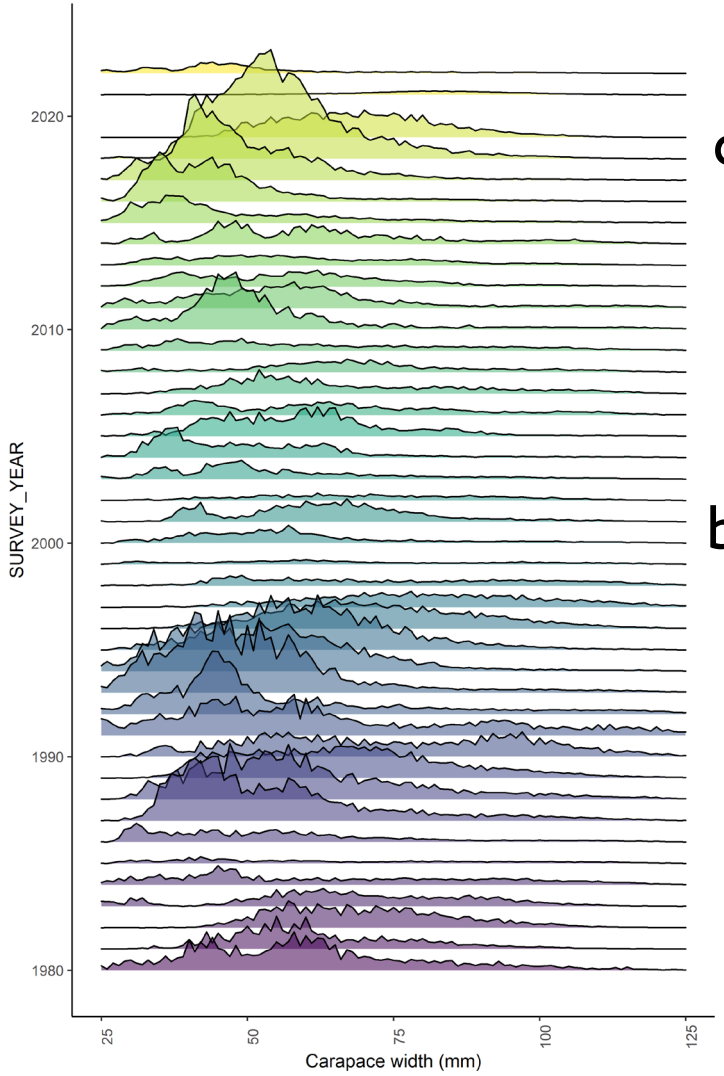
All measures of survey abundance are at or near **all-time lows**.

Survey MMB (morphometrically mature) was -40% compared to last year's all time low.





STOCK STATUS



Small male recruitment signal in <50 mm carapace width range, but need more years to corroborate given false starts in the past.

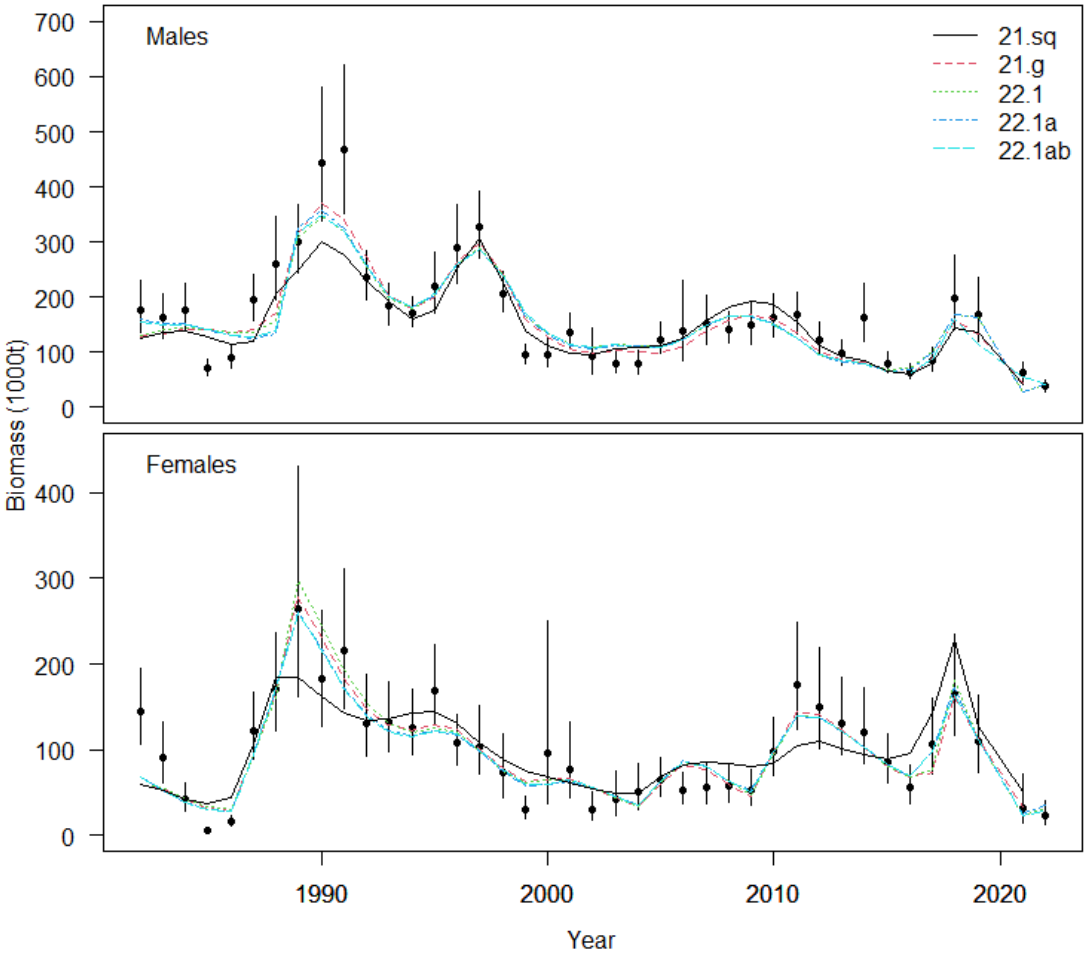
If this recruitment follows through, it will be 4 to 5 years before it potentially hits the fishery.

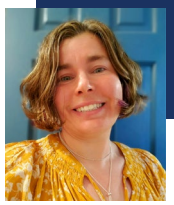
Until then, the commercially preferred fraction of the population will likely continue to decline.

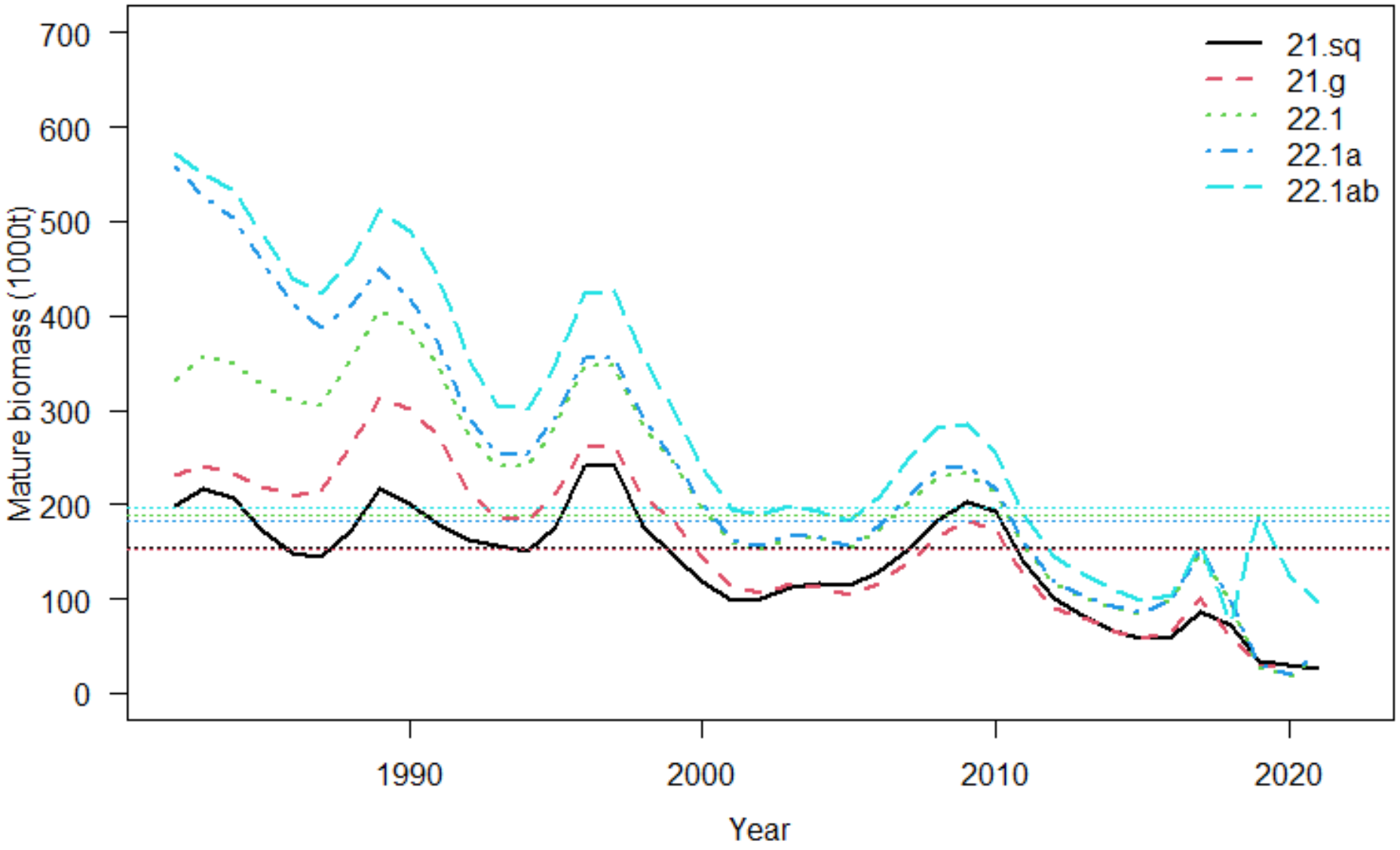
STOCK CONCERNS AND SUMMARY

- Crab maturity and terminally molting at smaller sizes
- Female clutch fullness is low and proportion of empty clutch is higher than previous years
- Fishery CPUE was at an all time low (small fishery this last season)
- Model stability issues dealing with recent unprecedented mortality event which coincided with lack of 2020 survey data
- CPT discussed three Tier 3 model options and Tier 4 calculations (as an option due to model convergence issues)
- CPT recommended model 22.1a (Tier 3) with a 25% buffer on ABC, SSC endorsed this recommendation.

Model fit to NMFS trawl survey data



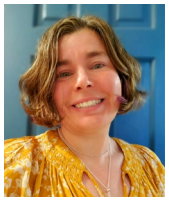



700
600
500
400
300
200
100
0
Mature biomass (1000t)
1990
2000
2010
2020
Year
21.sq
21.g
22.1
22.1a
22.1ab

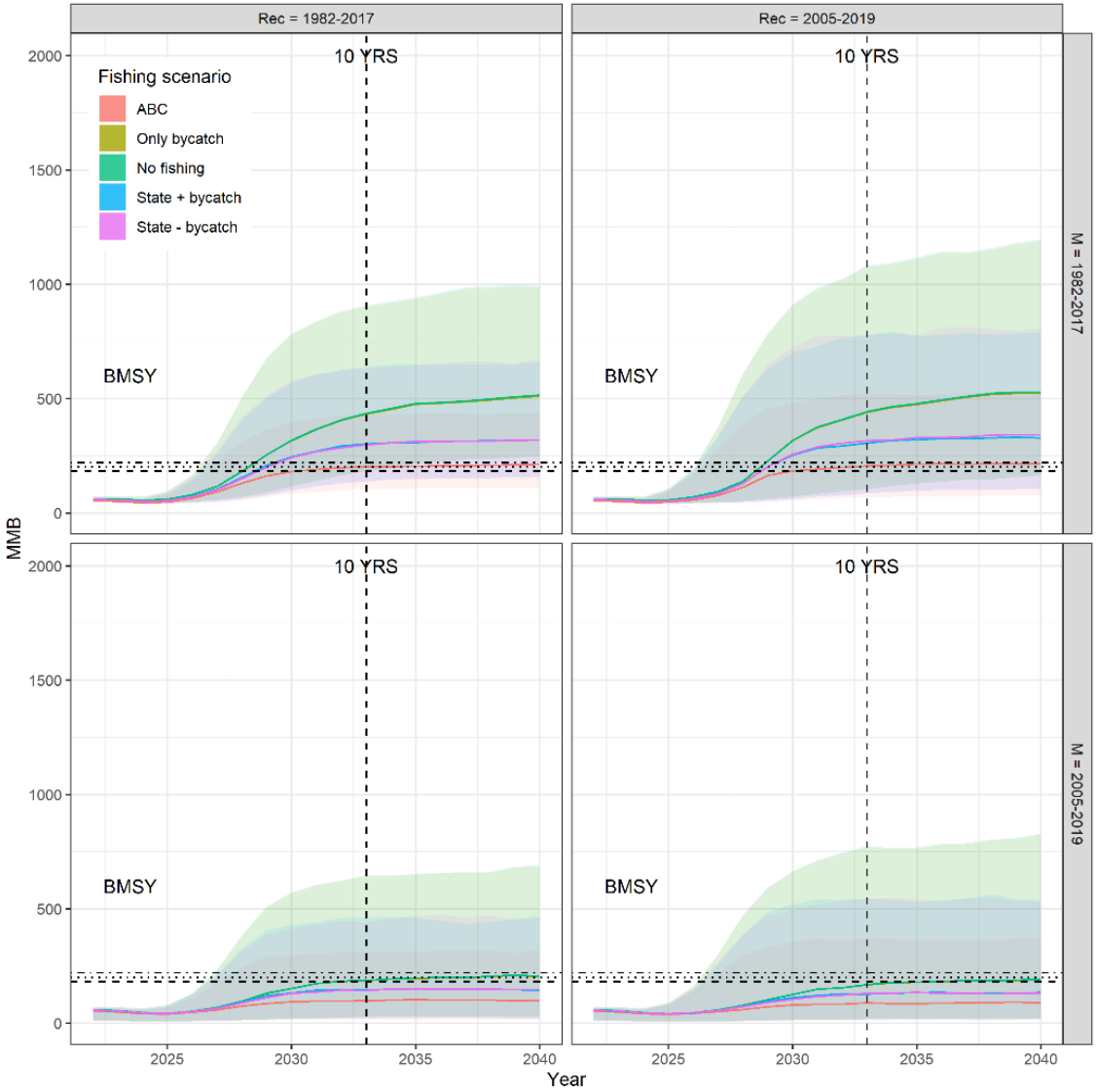
Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2018/19	63.0	123.1	12.5	12.5	15.4	29.7	23.8
2019/20	56.8	167.3	15.4	15.4	20.8	54.9	43.9
2020/21	76.7	26.7	20.4	20.4	26.2	95.4	71.6
2021/22	91.6	41.2	2.5	2.5	3.6	7.5	5.6
2022/23		55.0				10.3	7.7

Year	Tier	BMSY	MMB	Status	Proj_Status	FOFL	Years
2022/2023	3b	183.1	41.2	0.23	0.3	0.32	1982-2021

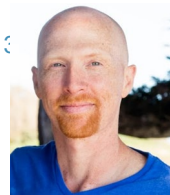
Total catch < OFL, overfishing is not occurring
Stock status < 0.50, stock is still overfished (rebuilding plan initial review scheduled for Dec)
25% Buffer recommended by CPT (and SSC)



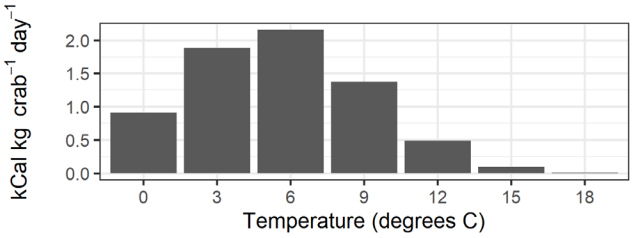
PROJECTIONS (22.1A)

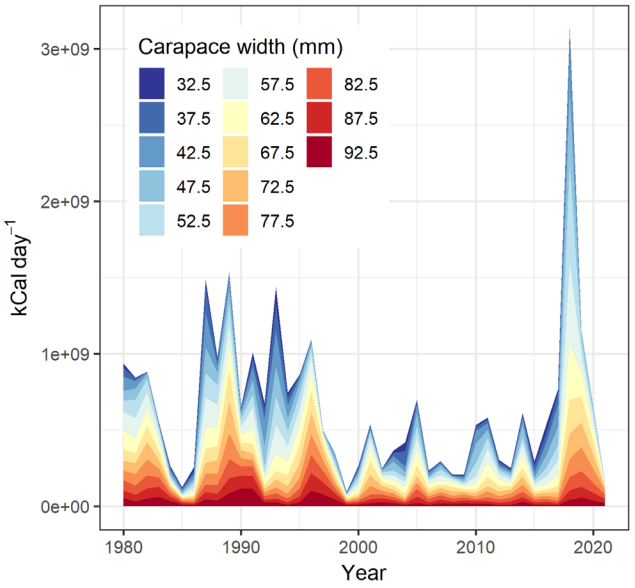


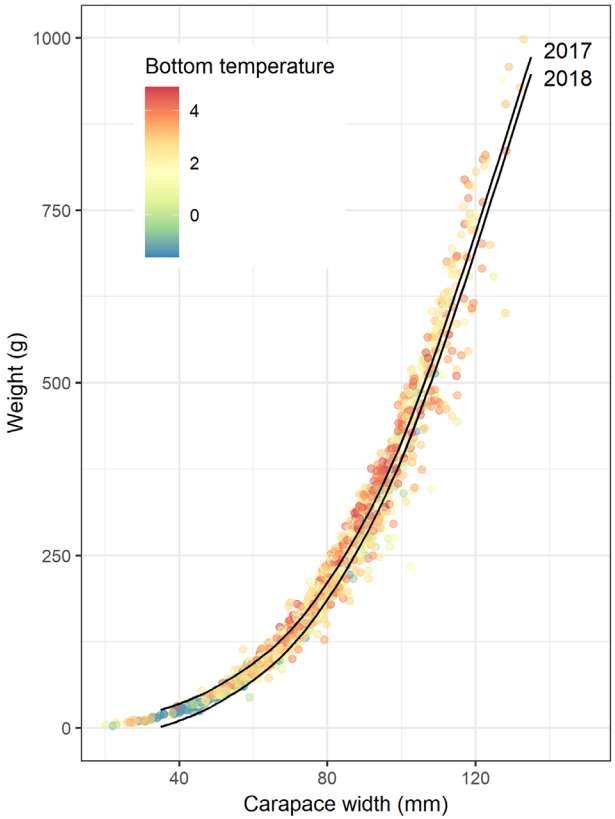
- Average recruitment from both periods are similar
- Tmin ranged from 2029 to never depending on scenario

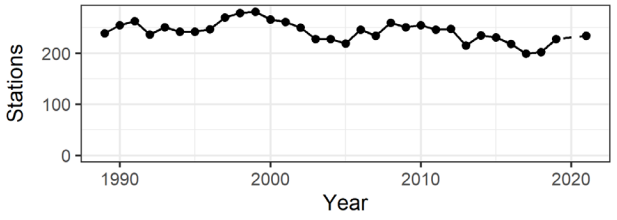


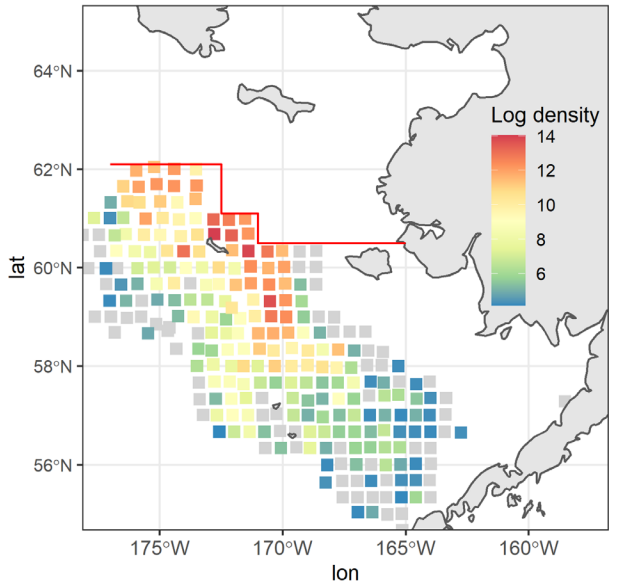
HIGH CALORIC REQUIREMENTS AND SMALL SPATIAL FOOTPRINT











M, *R*, AND UNOBSERVED MORTALITY

CPT recommendations:

- ***M* modeled with draws from the 1982-2017 time block**
  - The 2005-2019 time block is considered to be a better choice for simulating climate conditions during rebuilding
  - Available data suggest that high population density was a cause of the post-2018 collapse; high density will not be a concern during rebuilding
- ***R* modeled with draws from the 1982-2017 time block**
  - Lower *R* is consistent with expectations for low ice cover during rebuilding, and resulting reduction in average *R*
- **Status quo approach for estimating unobserved mortality**
  - Unobserved mortality had little effect on rebuilding when estimated at five times observed mortality
  - Estimating unobserved mortality at 100 times observed mortality creates complexities in population model and catch allocation that require more study before being implemented

RECOMMENDED T_{MIN} AND T_{MAX}

- **Rebuilding timeline**
  - The recommended approach for projecting *M*, *R*, and unobserved mortality results in T_{min} = 2029 (6 years from 2023)
  - Since T_{min} is less than ten years, the recommended T_{max} = 2033 (10 years from 2023)
  - CPT recommends this as the most realistic scenario given the data that are available to model the stock post-collapse (i.e., only with survey data from 2021 and 2022)

ST. MATTHEW BLUE KING CRAB

FINAL ASSESSMENT, OFL/ABC SPECS

ESP REPORT CARD SUMMARY:

Ecosystem Considerations

- In 2022, **bottom temperatures returned to near-average** and the cold pool extended into the majority of the St. Matthew Island management area.
- **Above-average chlorophyll-*α* biomass** in the St. Matthew Island management area indicates suitable primary production conditions for larval survival
- Despite repeated fishery closures, **SMBKC recruitment remains below-average,** although recruit abundance increased from 2021 to 2022
- **Persistent, corrosive bottom waters** surrounding St. Matthew Island suggest potential impacts on shell formation, growth and survival of BKC if declines in pH continue
- **Above average chlorophyll-a biomass and benthic invertebrate density** in recent years suggests optimal foraging conditions for both larval and benthic stages of SMBKC

Socioeconomic Considerations:

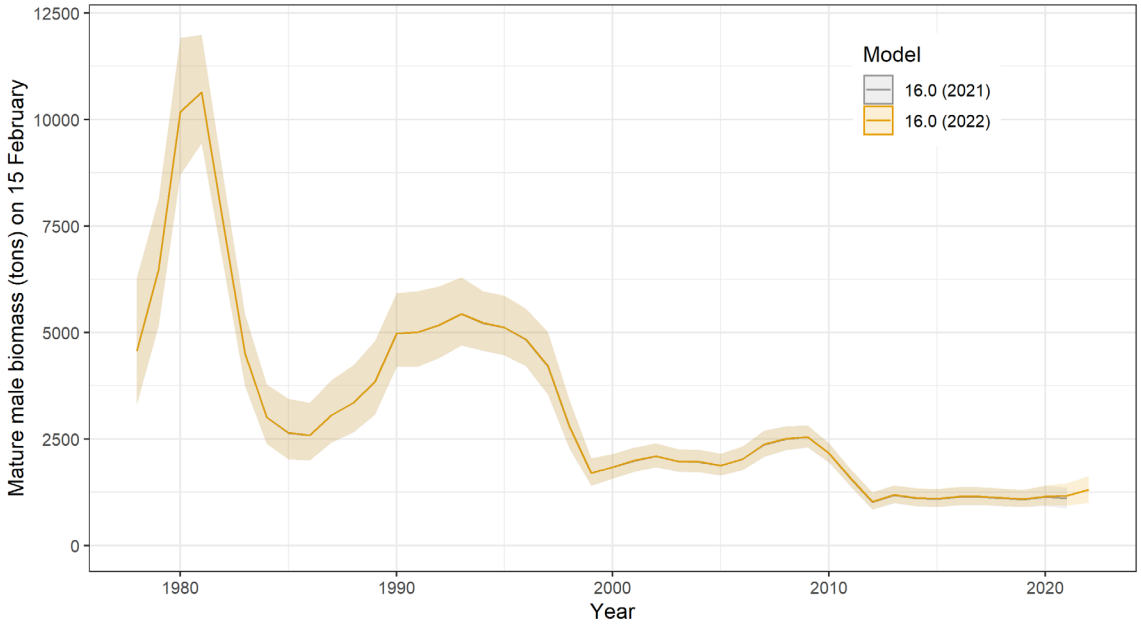
- The SMBKC fishery has remained **closed to targeted fishing** since 2015 (the 2015/2016 crab season).
- **Incidental catch** of SMBKC biomass in EBS groundfish fisheries during 2021 **declined substantially** from the previous year to the lowest value in the available time series, continuing a declining trend observed since a recent high in 2017.

SMBKC FINAL ASSESSMENT 2022: SUMMARY

- Last full assessment Sept. 2020 (moved to biennial cycle)
- Overfished, rebuilding plan in place since June 2020
- Progress towards rebuilding every 2 years (coincides with assessment cycle)
- Base model recommended for specifications
  - Consistency in model during rebuilding time frame
  - Known issues with model are still being explored but base model represents the best option at this time

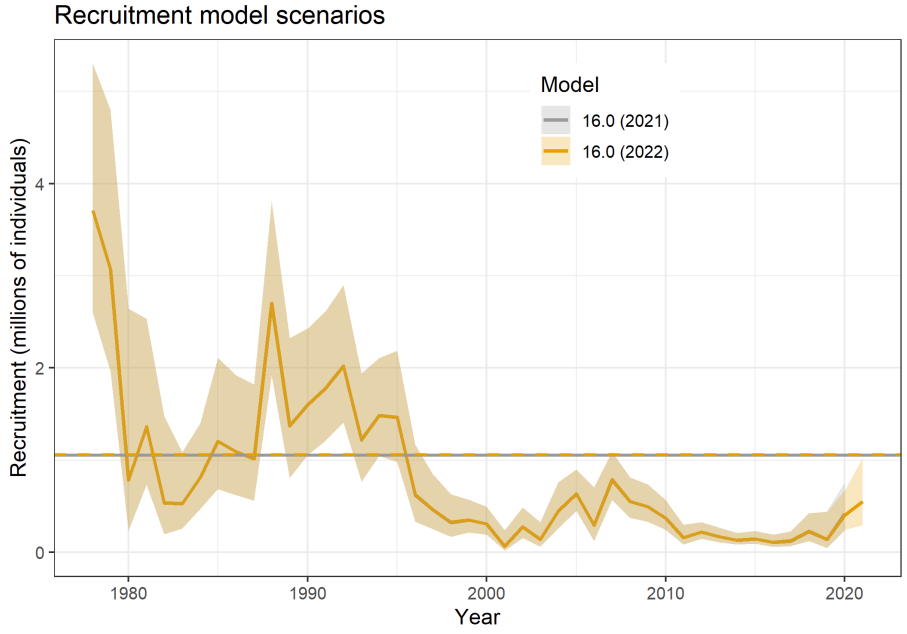
Mature male biomass:

- No discernable difference with updated reference model



Recruitment

- Increase in 2021 & 2022
- Trending up



2022/23 & 2023/24 SPECIFICATIONS

Table 1: Status and catch specifications (1000 t) for the base model.

Year	MSST	Biomass (MMB_{mating})	TAC	Retained catch	Total male catch	OFL	ABC
2018/19	1.74	1.15	0.00	0.00	0.001	0.04	0.03
2019/20	1.67	1.06	0.00	0.00	0.001	0.04	0.03
2020/21	1.65	1.14	0.00	0.00	0.001	0.05	0.04
2021/22	1.63	1.18	0.00	0.00	0.001	0.05	0.04
2022/23		1.31				0.07	0.05

Table 4: OFL and ABC are in tons.

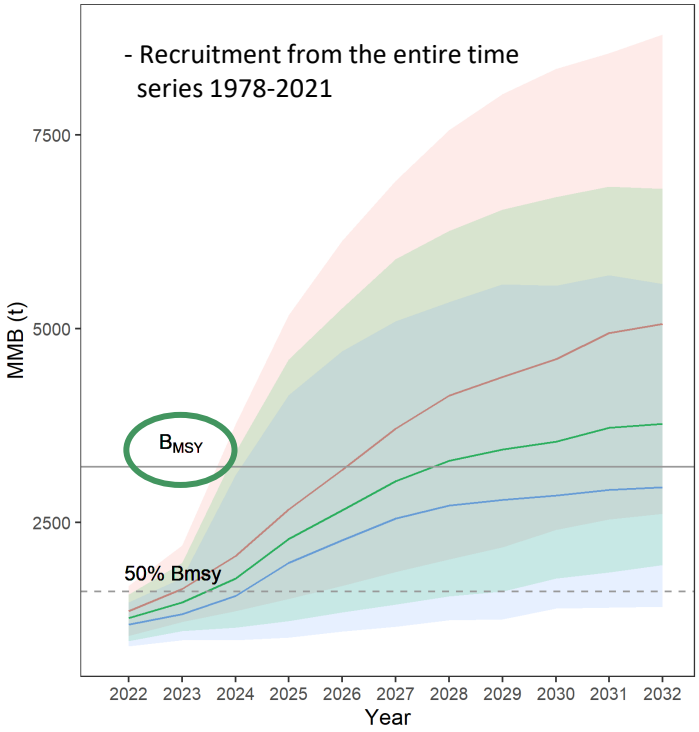
Component	Ref
MMB_{2022}	1175.056
B_{MSY}	3255.221
MMB/B_{MSY}	0.404
F_{OFL}	0.061
OFL_{2022}	66.333
ABC_{2022}	49.749

25 % ABC buffer

- Overfished
- Retrospective pattern MMB
- Poor recruitment
- Two survey trends diverge
- Limited stock specific life history information

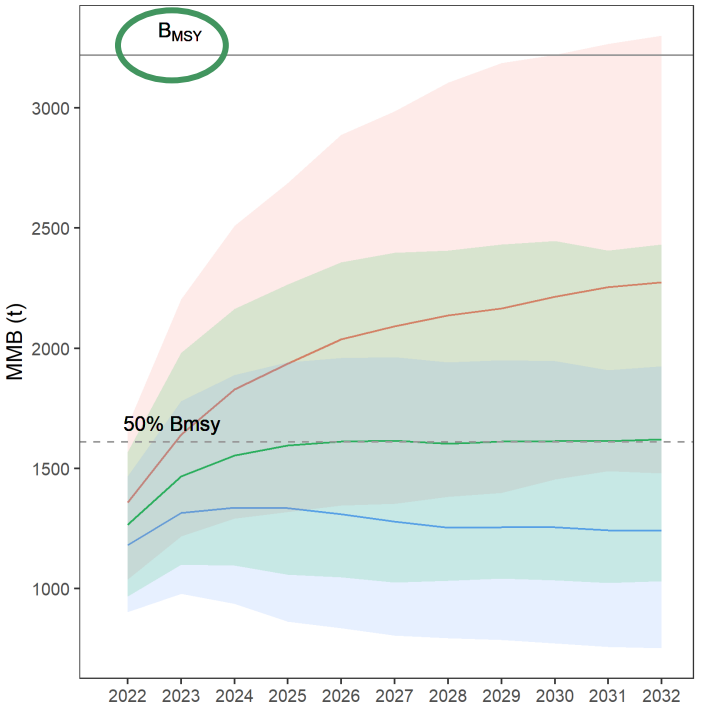
SMBKC final assessment 2022

Model 16.0 (2022)



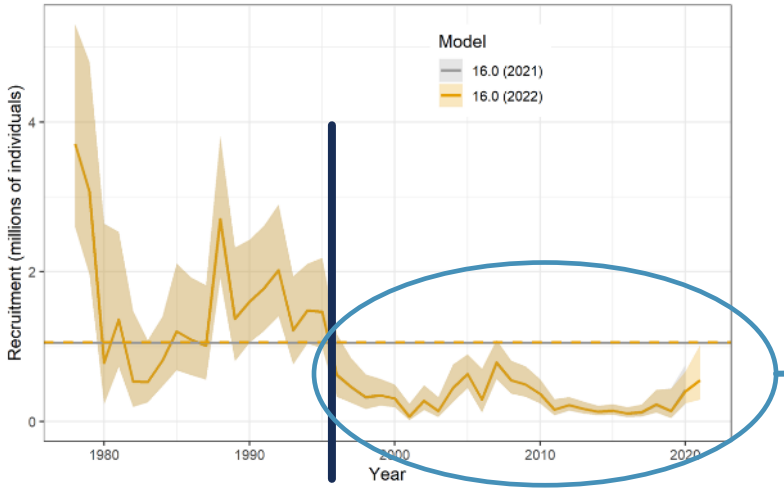
Fishing mortalit
F=0
F=0.09
F=0.18

Model 16.0 (2022) - recent recruitment (1996-2021)



Fishing mortality
F=0
F=0.09
F=0.18

Recruitment model scenarios



PRIBILOF ISLANDS RED KING CRAB (PIRKC)

FINAL ASSESSMENT 2022

PIRKC OVERVIEW

- **Management**: This is the first assessment since PIRKC shifted to a triennial management cycle in 2019.
- **Fishery**: No retained catch since 1998/99. Total bycatch is typically a small fraction of OFL.
- **Assessment methodology**:
  - Tier 4 stock
  - GMACS adopted in 2019.
- **Three models presented this cycle:**
  - **22.1** Model 19.1 updated with new data
  - **22.1a** 22.1 + bycatch size composition data, allowing estimates bycatch selectivity
  - **22.1b** 22.1a + constant growth increment; more consistent with approach for other RKC stocks

MODEL SELECTION, BUFFER, AND CPT RECOMMENDATIONS

- **Model 22.1b recommended by CPT (base model + bycatch size comps + constant growth increments)**
  - Fits data well
  - Includes additional data source (bycatch size comps); improvement over 22.1 (base model)
  - Treats biology (molt increments) more realistically given current understanding of Bering Sea RKC life history
- **25% buffer recommended**
  - Model borrows life history information from other stocks
  - Buffer is consistent with other low-information king crab stocks (SMBKC, PIBKC)

PIRKC STATUS AND SPECIFICATIONS

Management quantities for each scenario considered. Status and MMB were estimates for February 15 of the completed crab year. Values are in units of tons.

Model	MMB	B35	F35	FOFL	OFL	M	avg_rec	Status
22.1b	3878.98	1709	0.21	0.21	685.07	0.21	0.96	2.27

Values in t, shaded areas indicate new projections or estimates based on the current assessment.

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2018/19	866	5,368	0	0	7.22	404	303
2019/20	866	6,431	0	0	3.84	864	648
2020/21	866	6,431	0		5.09	864	648
2021/22	854	3,879	0		1.47	864	648
2022/23	854	3,879	0			685	514
2023/24		3,879	0			685	514
2024/25		3,879	0			685	514

- Not overfished
- No overfishing

BALANCE OF CPT REPORT

PIGKC, PIBKC, AIGKC, WAIRKC OVERFISHING UPDATES

OVERFISHING UPDATES

- **Pribilof Islands golden king crab**
  - Tier 5, no Minimum Stock Size Threshold estimate
  - 2021 total catch = 21 t, OFL = 93 t; *overfishing did not occur*
- **Pribilof Islands blue king crab**
  - 2021 total catch = 0.102 t, OFL = 1.16 t; *overfishing did not occur*
  - Mature Male Biomass = 180 t, Minimum Stock Size Threshold = 2,049 t; *the stock is overfished*
- **Aleutian Islands golden king crab**
  - 2021/2022 total catch = 3.056 kt, OFL = 4.817 t; *overfishing did not occur*
  - Mature Male Biomass = 13.065 kt, Minimum Stock Size Threshold = 5.821 kt; *the stock is not overfished*
- **Western Aleutian Islands red king crab**
  - Tier 5, no Minimum Stock Size Threshold estimate
  - 2021/2022 total catch < 1 t, OFL = 56 t; *overfishing did not occur*